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THE STATIC MAGNETIC FIELD EFFECT ON *PSEUDOMONAS AERUGINOSA*

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ABSTRACT
The bacteria *Pseudomonas aeruginosa* were isolated from medical case in Rizgary Hospital in Erbil-Iraq and identified using API 20 E system. Bacterial growth was exposure to difference magnetic field (400, 800, 1200 and 1600 Gauss during 2 to 20 hours) which prepared locally, as well as their susceptibility to common antibiotics were done in Hawler Medical Research Centre. Results illustrates that magnetic field decreased the growth rate of the bacteria, while increased the logarithmic phase within 4 hours of exposure. API 20 E system showed that the magnetic force could alter bacterial ability to ferment sugars, while its increase in *Pseudomonas aeruginosa* sensitivity to antibiotic during a short period (4-6 hr.) and increase its resistance to same antibiotic at long term of exposure (18-20 hr.) go on comparing with the control (non exposure to magnetic force). The bacterial enzymes such as, TDA, GLU, ARA, are effected by magnetic field.

KEY WORDS: Antibiotics susceptibility test, Magnetic field, *Pseudomonas aeruginosa*

INTRODUCTION

Previous developments of directional magnetic fields began in 1936, when Davis and Rawls (1974) first discovered that the north and the south magnetic pole fields each exhibited unique properties with respect to their effects on various forms of life. This discovery was slow to be accepted because of investigations by others who confused Davis' directional polarities magnetic fields with those which are simultaneously emitted by horse shoe type magnets and by AC-powered electromagnets. Magnetic enhancement of bacterial or cellular growth rates has been reported in the literatures. For example, Davis and Rawls presented numerous examples of enhancement to seeds and various types of cellular growth (Davis *et al.*, 1974).

Authors were studied the effect of pulsed magnetic field intensity and pulse number (PMF) on bactericidal property of PMF in sterilization of fresh watermelon juice (Ma *et al.*, 2003). Their results showed that the overall bactericidal effect was strengthened as the magnetic field intensity and pulse number increased with the best effect observed when the magnetic field intensity was 2.53 T and pulse number was 20. Investigations sponsored by Bio-Magnetics Systems, Inc. have shown that unidirectional magnetic fields inhibited or increased the growth of cancer cells, depending on the field polarity, as disclosed by Trappier (Trappier, 1990). So the effects of magnetic fields were studied in different areas such as drug delivery, cancer therapy, sterilization, and water treatment (Haghi *et al.*, 2012).

Magnetic field affects DNA synthesis and transcription (Phillips *et al.*, 1992) as well as ion transcription through all membrane (Liburdy *et.al*, 1993). Piatti and his coworker (Piatti *et al.*,2002) found that the exposure of the bacteria *Serratia marcescens* to a static magnetic field 80 $\pm$20 Gauss resulted in inhibition of growth. The effect of magnetic field was variable depending on the type of the microorganism and field. Study was clarified that magnetic field has significant effect on bacterial cell as well as on its life and they added that the effect of magnetic field was enclosed in cell membrane (Novak *et al.*, 2007). Other study found that *E. coli*, bacteria decarboxylation and *Staphylococcus aureus* viability affected with the magnetic field (10 mT, 50 Hz) (Fojt *et al.*, 2004). Nasher and Hussein (2008) concluded that magnetic field effect on bacteria could be considered as bactericidal. The aim of our objectives were to study the effects of different exposure periods to 400, 800, 1200 and 1600 G locally prepared static magnetic field on the cell activity. The effects of such magnetic fields on the growth rate and antibiotic sensitivity were explored, too.

MATERIALS AND METHODS

The bacteria Pseudomonas aeruginosa colonies were isolated and identified on culture media of patients samples in Rizgary hospital and suspend into 10 ml^{-1} of nutrient broth, incubated at 37 ºC for 24 hour as a stock culture. Dipolar magnetic field was prepared locally with different forces including 400, 800, 1200, 1600 Gausses and measured by Teslometer in Physical Department, College of Science, University of Salahddin, Erbil, Iraq. 0.1 ml^{-1} of stock bacterial suspension will be inoculated in to five groups of tubes contains $5ml^{-1}$ of nutrient broth. Four groups of tubes were subjected to magnetic field (400, 800.1200,1600 Gauss) respectively. While the fifth group did not subjected to

magnetic field as a negative control, later all tubes groups incubate at 37 ºC for 2 to 20 hours. The effects of different forces of magnetic fields on growth rate were evaluated by measurement of the optical density using McFarland Turbidity Standards (0.5) process (Kohno *et al.,* 2008). The API kits were prepared by BioMerieux Company and used due to process BioMerieux Company. Inoculation of API kit with bacteria from each group done separately (EL-Sayed *et al.,* 2008).

Antibiotic susceptibility test were done using Muller-Hinton Agar medium depending Kirby-Bauer Disk Diffusion technique. Gentamycin (30mcg), Tetracycline (10mcg), Vancomycin (10mcg), Polymyxin (30unie/UI), Chloramphenicol (30µg), Tobramycin (10mcg), Rifampcin (5mcg), Ceftazidium 30mcg),Trimethoprim (10mcg),Sulfamethoxazole-Trimethoprim (23.75 µg -1.25 µg),Ceftriaxone (30mcg) disks were placed over the media. The antibiotics used in this study were chosen to be with different modes of action. The diameters of the inhibition zone were measured after 24 h from the exposure process (Mohamed *et al.,* 1997).

RESULTS AND OBSERVATION

Results obtained in this study indicated that difference magnetic field (400, 800, 1200, and 1600 G.) increased the logarithmic phase of *Pseudomonas aeruginosa* growth (within 4 hours of treatment, but decreased growth curve after a period of 8 hours (Figure 1). So a considerable changes in the growth rate of *Pseudomonas aeruginosa* (Table 1). We found that the decrease of the colony forming units (CFU) starts immediately after the magnetic field was switched on and that magnetic field effect on bacteria could be considered as bactericidal.

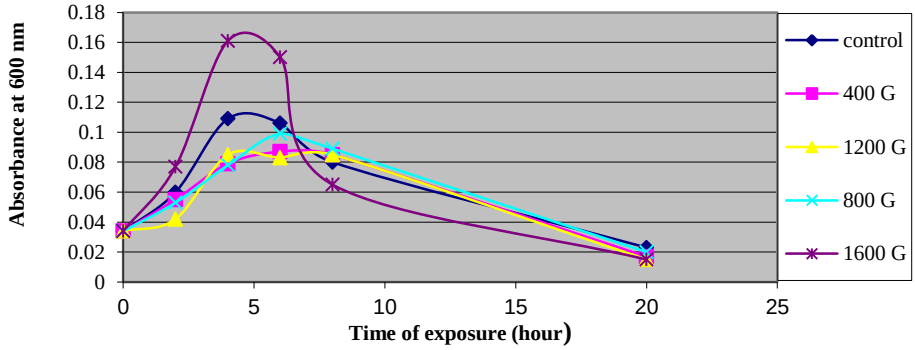


Figure 1. Absorbance at 600 nm of *Pseudomonas aeruginosa* cells with different exposure periods.

Table (1) the growth rate of *E. coli* for each group is determined by spectrophotometer

Time of exposure to magnetic field in hr.	Optical Density (O.D.) at 600 nm.				
	Control	400G	800G	1200G	1600G
0	0.034	0.034	0.034	0.034	0.034
2	0.06	0.055	0.042	0.053	0.077
4	0.109	0.079	0.085	0.078	0.161
6	0.106	0.087	0.083	0.099	0.15
8	0.08	0.085	0.085	0.089	0.065
20	0.023	0.017	0.015	0.02	0.015

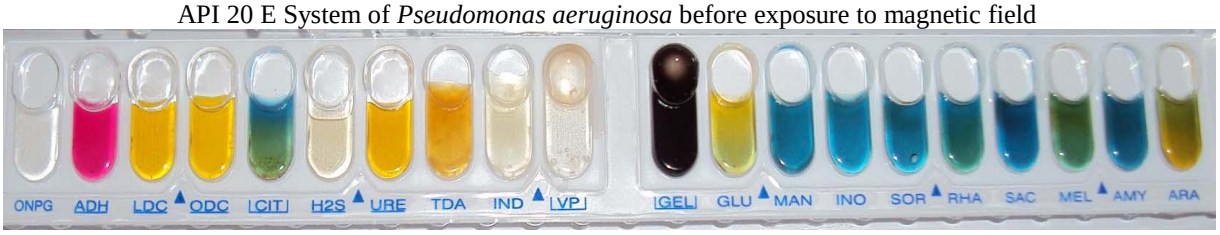
Table (2) showed antibiotics susceptibility test difference period of time (2, 4, 6, 8, 20 hour) were evaluated according mode of action, the results concluded that *Pseudomonas aeruginosa* were sensitive for Gentamycin, Polymyxin, Tobramycin and Ceftazidium. Also the results indicated that magnetic field alter antibiotic sensitivity and found that exposing *Pseudomonas aeruginosa* to magnetic field increased antibiotic resistance absolutely in Ceftazidium. The diameters of the inhibition or stimulation zone of the difference magnetic forces were measured after 24 h from the exposure process compared with unexposed samples. According to API 20E, the bacterial enzymes TDA, GLU and ARA are affected by magnetic field at 24 hours incubation (figure 2).

Table (2): The antibiotic test of exposed and unexposed *Pseudomonas aeruginosa* to magnetic filed

Antibiotics	Mode of action	Inhibition antibiotics zone diameter in cm								
		Unexposed	M.F exposure (G) time							
			2 h				20 h			
			400	800	1200	1600	400	800	1200	1600
Gentamycin	Inhibition of protein synthesis	2.0	2.1	2.1	2.1	2.0	2.0	1.8	1.5	1.3
Polymyxin	Alteration of cell membrane	1.5	2.0	1.5	1.5	1.2	1.4	2.0	1.0	1.0
Tobramycin	Inhibition of nucleic acid	3.0	2.2	2.2	2.5	2.3	2.5	2.1	2.0	2.0
Ceftazidium	Inhibition of cell wall	2.0	2.0	2.2	1.5	1.0	1.5	R	R	R

R: Resistance, M.F: Magnetic Field

API 20 E System of *Pseudomonas aeruginosa* before exposure to magnetic field



API 20 E System of *Pseudomonas aeruginosa* after exposure to magnetic filed

Figure 2. API 20 E System of exposed and unexposed of *Pseudomonas aeruginosa* to Magnetic field

DISSCUSION

This work is concerned with the study of biological effect of magnetic field on *Pseudomonas aeruginosa* because it is widely distributed in the environment and it is caused several diseases. Our result found that the magnetic field could be used as inhibitory factor against the bacteria. Many researchers have been done to study the effect of magnetic field on bacteria (Nasher *et al.*, 2008; Mohamed *et al.*, 1997; Stansell *et al.*, 2001) whom reported on exposure of *E. coli*, *Staphylococcus aureus* and *Salmonella typhi* to the magnetic field.

Results demonstrated that the magnetic field changes the sensitivity of *Pseudomonas aeruginosa* to antibiotics and this agree with study done by Ceon *et al.*, (2005) who found that exposure of *E. coli* to static magnetic field increased its antibiotic resistance. Our results suggest that the biological effects of magnetic fields may critically depend on the physical characteristics of the magnetic signal, in particular the wave forces. So treating enzyme with different magnetic fields can inhibit or promote enzyme activity according to API 20 E. We could also identify the *Pseudomonas aeruginosa* by this test. We concluded that the results obtained in this study illustrates that the growth rate of *Pseudomonas aeruginosa* cells were affected by exposure to magnetic forces (400, 800, 1200 and 1600). In addition to that the magnetic field increased the logarithmic phase within 4 -6 hours of treatment, but it was decreased after 16 to 18 hours go on comparing with the control. The bacterial enzymes such as, TDA, GLU, ARA, are effected to magnetic field. So our experiment appears that treating enzyme with different magnetic fields forces could inhibit or promote enzyme activity according to API tests. Furthermore, the bacterial sensitivity to antibiotics were increased after exposure period of 6 h to certain antibiotics, but become resistant after 16 hrs.

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